Space Weather Technical Forecast

Issued on Monday, 29 August 2022 at 01:18 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-class flares (R1-R2) likely at first. G1/Minor Storm likely with CME glance day 1. Chance of further Minor Radiation storms (S1).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Moderate, with the background X-ray trace at GOES16 comfortably residing at C-class levels. Further M-class flares were observed from AR3088 (Ekc/Beta-Gamma) which is now disappearing across the southwest limb. A peak flare M6.7 was observed at 28/1619 UTC, and this gave a coronal mass ejection (CME) that is probably not fully directed towards Earth. AR3089 (Eki/Beta-Gamma-Delta) in the southeast, whilst less active, is another region of note, with some growth observed, including the emergence of a negative polarity spot near its positive trailer, resulting in a subsequent small delta spot development. AR3087, near centre disc has simplified further in recent hours and both AR3085 and AR3086 remain simple with little overall change observed. No other Earth-directed CMEs were observed occurring in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, was at mostly slightly elevated levels between 400-500 km/s due to the high speed stream (HSS) related to CH18/-. The associated density was near average throughout. The total interplanetary magnetic field (IMF), Bt, was at weak to moderate levels The north-south component, Bz, remained at weak levels ranging between +8/-6nT. The phi angle was negative (towards the Sun) throughout. Geomagnetic activity was Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV), as measured by GOES-16 was at just below S1/Minor Radiation storm levels with an erratic decrease observed. The high energy electron flux (greater than 2 MeV) remained at Background levels. The 24-hour integrated electron fluence remained below the Active threshold (1e8 integrated pfu) with a downward trend noted and 1.46e6 integrated pfu observed at 29/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Further M-class flares are likely with a slight chance of an isolated X-class flare. This risk will probably decrease through the period as the main sunspot in the southwest AR3088 rotates off the disc, however the sunspot in the southeast AR3089 will need to be monitored for any further development.

Solar Wind / Geomagnetic Activity: A moderately fast CME generated from the M4.7 flare of AR3088 on 27 Aug has the potential to give a glancing arrival on day 1. Ongoing coronal hole HSS enhancements are possible from CH17/- during the next two days (29th and 30th), with the elevated solar winds only gradually easing from day 3 (31st) onward. Geomagnetic Activity is expected to be Quiet to Unsettled at first, with a chance of Active from any transition to CH18 HSS effects, and with G1/Minor Storms likely with a chance of G2/Moderate storms from any

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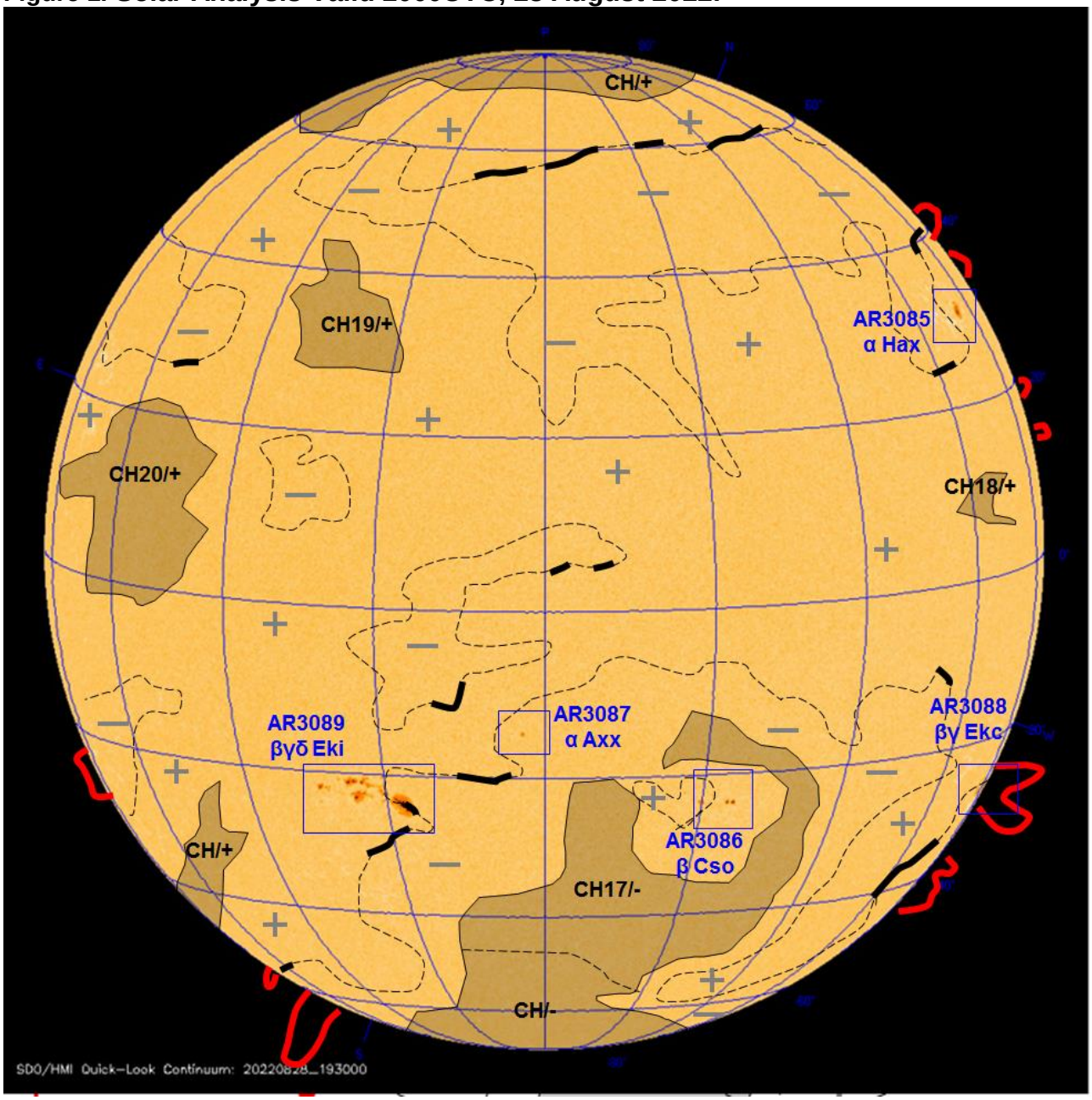
CME glance. Mainly Quiet geomagnetic conditions expected from day 3 (31st).

Energetic Particles / Solar Radiation: High energy protons (greater than 10MeV) are expected to continue gradually and erratically declining, with a chance of further enhancement, mainly from any notable flares from AR3088 days 1 and 2 (29th and 30th). The high energy (greater than 2 MeV) electron flux forecast is expected to remain mostly at background, but likely rising again to Moderate, perhaps peaking High, once any fast wind enhancement or CME influence fades by day 3 (31st Aug). The associated 24 hour fluence is excepted to remain below the Active (1e8 integrated pfu) threshold, but with a chance (20 to 30%) of rising above towards the end of the guidance period.

Figure 1. Solar Analysis Valid 2000UTC, 28 August 2022.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:

The M4.9 flare of AR3088 on the 27th, produced a relatively fast CME, energetically departing the Sun at 1250 km/s, This has been analysed as giving a mainly glancing impact to earth on day 1. This has relatively low confidence however, with much of the material expected to probably pass ahead and over Earth.

Earth is currently within a slow-ambient to slightly elevated solar wind regime (400 km/s) and a transition into a HSS related to CH19, a negative polarity hole, during day 1 (29 Aug). The solar sector boundary crossing (SSBC) when this transition occurs may give some increased geomagnetic activity, especially if alongside the CME arrival. This is a broad feature, with elevated solar winds then expected to persisted until day 3 (31 Aug), similar to persistence, which is currently considered to be giving good guidance.

Quiet to Unsettled geomagnetic activity conditions expected, with Active intervals from the transition into CH18 during day 1 (29 Aug). However the forecast arrival of the CME glancing impact is likely to bring G1/Minor Storm in the coming hours, with a chance of G2/Moderate Storms. Mainly Quiet conditions expected from day 3 (31 Aug).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	60	20	1	1
Strong	G3	No	15	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
27/0230	Partial	M4.7 flare from AR3088	SW	1250	29/0100 UTC +/- 9h	Glancing blow / Mot material probably missing Earth

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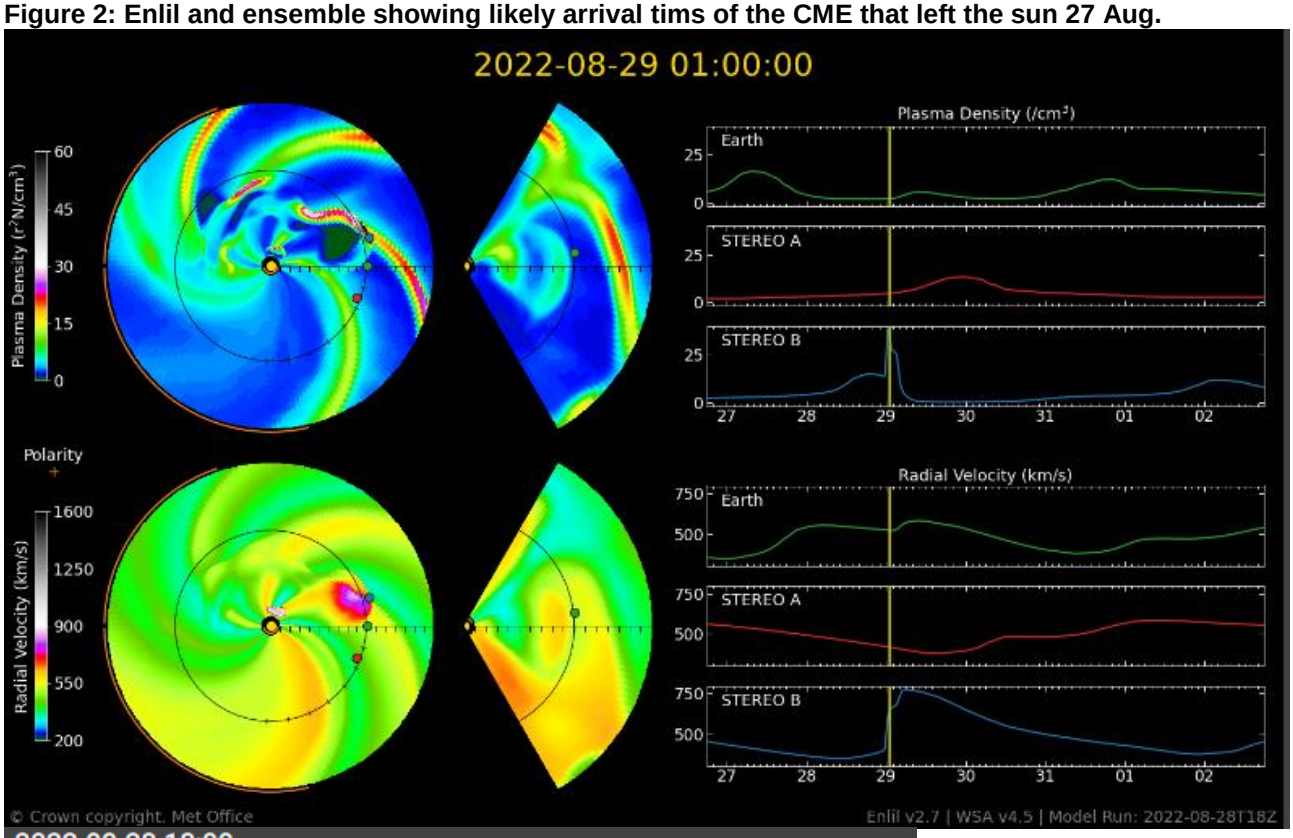
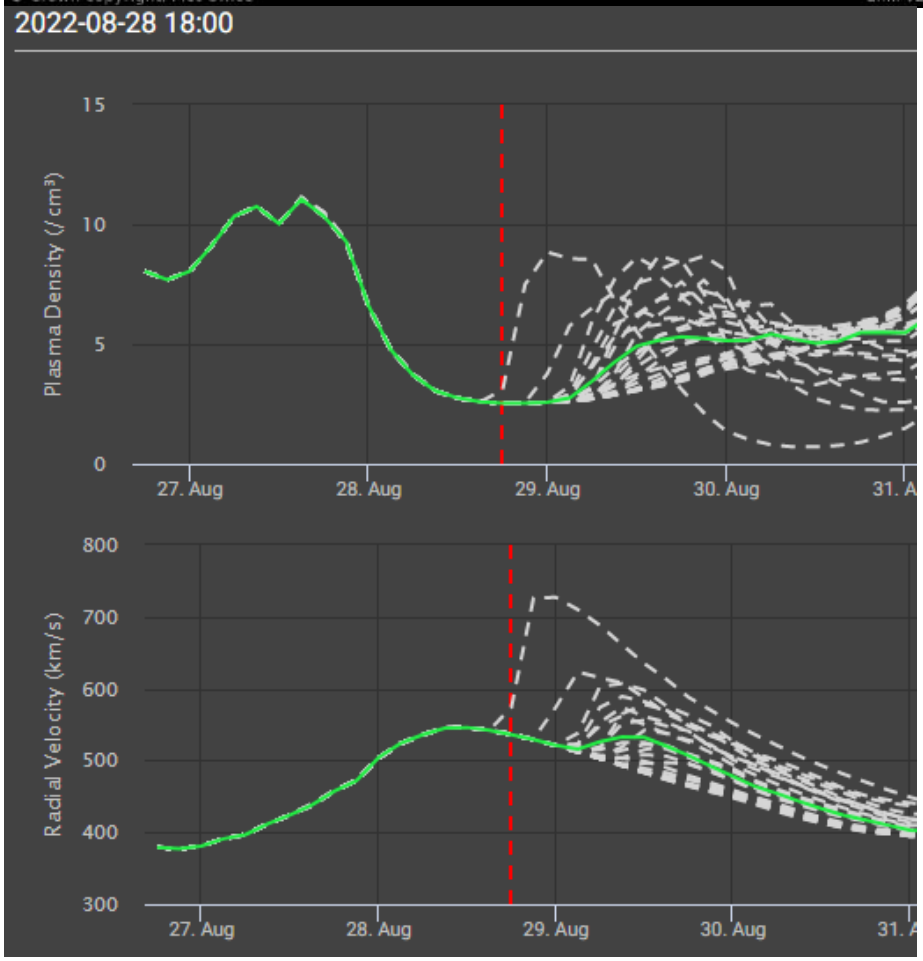
Figure 2: Enlil and ensemble showing likely arrival tims of the CME that left the sun 27 Aug.





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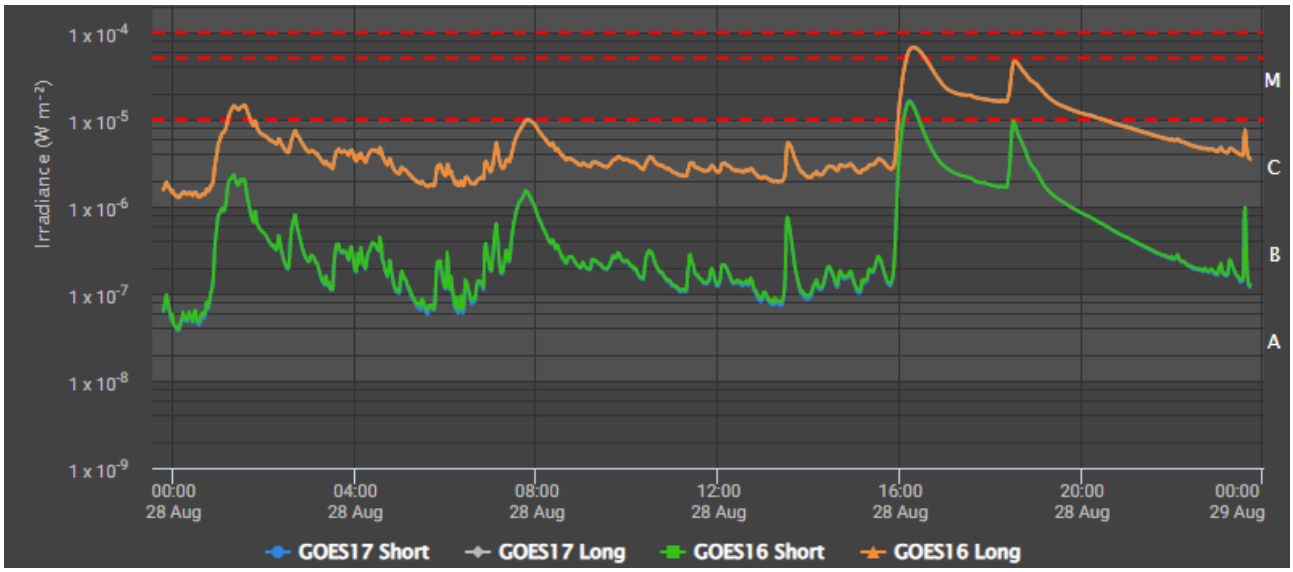
Radio Blackouts - X-Ray Flares:

Solar Activity remains Moderate with a few M-class flares observed, originating from AR3088 (Ekc/Beta-Gamma). This region is now disappearing across the southwest limb. Any notable flaring has the potential to still impact Earth until day 2 (30th), due to the magnetic looping above the spot. Due to its location, this spot is now impossible to accurately analyse, so its previous assessment will remain valid until it rotates off the disc, with further M-flares likely from this region, and a chance (20%) of X-class flares.

AR3089 (Eki/Beta-Gamma-Delta) in the southeast has also seen some increased magnetic complexity with the emergence of an opposite polarity sunspot near its main positive trailer spot, along with a proliferation of other spots. This has resulted in the formation of a small delta spot. Furthermore, this region has a history of higher M-flares (R2) flares (on the 26th) and any further growth will also give a risk of Moderate to Strong flares. However, no significant activity has currently been observed, since the 26th.There are three other sunspot regions on the disc, however these are smaller and simpler.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	30	30	30
Very Active	R3 to R5 X Class	No	20	5	5	5

Figure 3: Latest plot of X-ray flux at GEO from GOES instruments.



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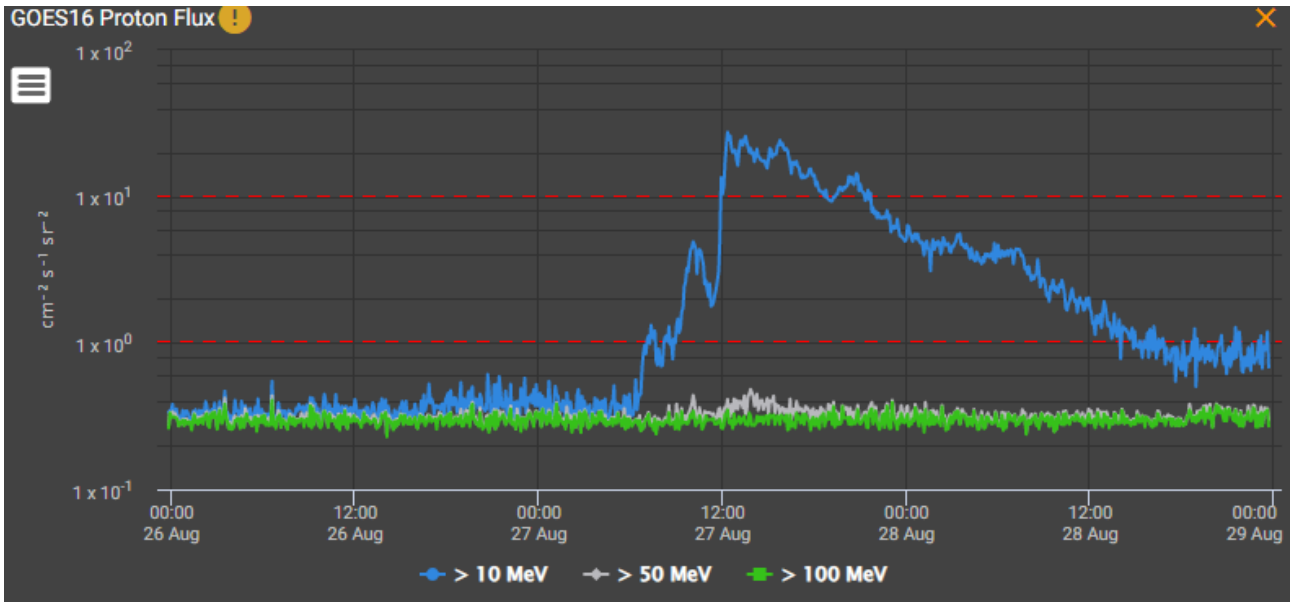
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) is currently gradually, if rather erratically, declining towards background, after reaching the S1 level due to an M4.7 flare from AR3089 on the 27th, with a peak of 28pfu at 27/1220UTC.
This shows the potential for any flaring from this active region to offer a chance of further S1 or greater through the coming days. Although this region will rotate off the visible disc early on the 29th, with a subsequent gradual reduction in proton storm risk as it moves further around the far-side. Although any far-sided flares can still result in an increase in proton flux.
There is also further slight risk of proton storms as AR3089 moves across the visible disc onto the western hemisphere, and this region will need to be monitored for further development.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	45	45	20	5
Very Active	**≥ S3 ***	No	10	5	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES-16 >10MeV, >50MeV and >100MeV Proton Flux for the last 3 days.



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High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux as observed by GOES-16, has remained at background after recent solar wind enhancement and proton storming. Arrival at Earth of the predicted glancing CME during day 1 (29 Aug), alongside the transition into the HSS related to CH17, does have the potential to increase electron flux again once any subsequent geomagnetic activity subsides. However persistence from the previous rotation, suggests very little electron flux enhancement is likely from the fast wind of CH17.

Consequently, the associated 24 hour electron fluence is expected to remain below the Active threshold, with only a chance (20-30%) of rising above, mainly from day 2 (30 Aug) onward. This supported by the output from Met Office REFM, although this model doesn't take account of any CME arrival or upcoming fast wind enhancement, so is likely to be offering rather poor guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	20	20	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES-16 Electron Flux and Fluence with REFM and Recurrence.

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